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CHAPTER 5

WATER TREATMENT CHEMICALS

5-1. Chemical properties. Chemicals are used for a variety of purposes in conventional water treatment practice, including coagulation and flocculation, disinfection, taste and odor control, and pH adjustment. The most common chemicals and some of their characteristics are listed in table 5-1.

5-2. Chemical standards. Chemicals used at Army water treatment plants will meet the applicable standards of the American Water Works Association (AWWA). If chemicals meeting the AWWA standards are not available, then substitute materials may be used after they are evaluated and determined by the Surgeon General of the Army to be safe for drinking water.

5-3. Chemical handling and storage. In the design of water treatment facilities, the selection of methods of chemical handling and storage must be based primarily on ease of operation, operating flexibility, and safety considerations. If chemicals are to be received in shipping containers such as bags, boxes, drums, or canisters, equipment required for chemical handling may include carts, dollies, fork lifts, cranes, etc. If chemicals are shipped in bulk quantities, the mode of unloading depends on the physical characteristics of the chemical. Bulk liquids are usually unloaded by pumping from the tank truck or railroad car to the storage tanks at the treatment plant. Bulk powders can be unloaded by pneumatic unloading and conveyance devices, or if the powder is to be mixed or dissolved in water, it can be unloaded directly into a water eductor in which the powdered chemical and the water are mixed as the water is flowing to the storage tank. Chemical crystals or granules are usually unloaded by mechanical devices, such as bucket elevators and conveyor belts. All three forms of bulk chemicals can be unloaded by gravity if the chemical storage tanks or bins are located below ground near railroad tracks or roadway. Chemicals shipped in bags, drums, barrels, or other shipping containers can usually be stored by placing these containers in a specified storage area. The supply of chemicals in storage at a water treatment plant should always be at least equal to the projected 30-day requirements. Under some circumstances, it may be desirable to maintain larger supplies of essential chemicals, such as disinfectants or coagulants, and smaller supplies of nonessential chemicals. Extreme caution must be used when handling and storing most water treatment chemicals. Mishandling may cause death, injury, or at the very least, may render chemicals ineffective. Hazardous chemicals, such as chlorine gas, must be stored in separate rooms to avoid reaction of chemical vapors. When doubt exists as to the proper handling of certain chemicals, advice from the manufacturer or other technically competent authority should be sought.

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5-4. Chemical application.

a. Dry chemicals. Dry chemicals are usually converted to a solution or slurry prior to application to the water. Measurement of the chemical application rate is accomplished by the dry-feed machine. The measured quantity of chemical is then dissolved or slurried in a small amount of water for transport to the feed point, where the solution or slurry must be rapidly and thoroughly mixed with water being treated.

b. Liquid chemicals. Chemical solutions or slurries are applied directly, or after dilution, to the water being treated by volumetric liquid feeders such as metering pumps or rotating wheel feeders. Rapid, thorough mixing of the chemical solution or slurry with the water is essential.

c. Chlorine application. Hypochlorite solution will be fed by an injector, diaphragm pump, or centrifugal pump system. The point of discharge of the chlorine solution must be at least 2 feet below the water surface.

d. Corrosion. Special attention should be directed to the materials used for the critical parts of chemical feeders. Many chemicals form corrosive environments for common metals.

Table 5-1. Principal Chemicals Used in Water Treatment

Chemical Name and Formula	Common or Trade Name	Purpose	Shipping Containers	Suitable Handling Materials	Bulk Density lb/cu ft	Solubility lb/gal	Commercial Strength	Characteristics
Aluminum sulfate solution	Liquid alum	Coagulation	Tank trucks or tank cars	Lead or rubber-lined steel, 316 stainless steel, plastic	(11.047 lbs/gal)	-	5.36 lbs dry alum per gallon	pH of 1% solution is 3.4
Aluminum sulfate (dry), $Al_2(SO_4)_3 \cdot 14 H_2O$	Alum, filter alum, sulfate of alumina	Coagulation	100-200 lb. bags, 300-400 lb. barrels, bulk silicon (carloads).	Dry-Iron, steel. Solution-lead-lined rubber, barrels, bulk silicon, asphalt, 316 stainless steel	Powder 38-45 Granule 60-63 Lump 62-67	4.2 at 60°F	15-22% Al_2O_3	pH of 1% solution is 3.4
Sodium aluminate $Na_2OAl_2O_3$	Soda alum	Coagulation	100-150 lb. bags; 250-440 lb. drums; solution.	Iron, plastics, rubber, steel	50-60	Highly soluble	70-80% $Na_2Al_3O_4$, 32% $Na_2Al_3O_4$ minimum	Hopper agitation required for dry feed
Ferrous sulfate $FeSO_4 \cdot 7H_2O$	Copperas, green vitriol	Coagulation	Bags, barrels, bulk	Asphalt, concrete, lead, tin, wood	63-66	0.5 at 32°F 1.0 at 68°F 1.4 at 86°F	55% $FeSO_4$ 20% Fe	Hygroscopic; cakes in storage; optimum pH is 8.5-11.0
Ferric chloride $FeCl_3$ (37-47% solution)	Ferrichlor, chloride of iron	Coagulation	5-13 gal. carboys, trucks, tankcars	Glass, stoneware, synthetic resins	(11.2-12.4 lbs/gal)	-	37-47% $FeCl_3$ 13-16% Fe	Very corrosive
Ferric sulfate $Fe_2(SO_4)_3 \cdot 9H_2O$	Ferrifloc, Ferrisul	Coagulation	50-175 lb. bags, 200-425 lb. drums	Ceramics, lead, plastic, rubber, 18-8 stainless steel	56-72	Soluble in 2-4 parts water	66% Fe_2SO_4 20% Fe	Mildly hygroscopic, Coagulant at pH 3.5-11.0
Sodium silicate Na_2OSiO_2	Water glass	pH control	Drums, bulk (tank trucks, tank cars)	Cast Iron, rubber, steel	(11.6 lbs/gal)	Highly soluble	28.7% SiO_2	Variable ratio of Na_2O to SiO_2 . pH of 1% solution is 12.3
Chlorine	Chlorine gas, liquid chlorine	Disinfection	100-150 lb. cylinders, 1 ton containers, 16-30-55-85 and 90 ton tank cars, tank trucks (about 15-16 tons)	Dry - black iron, copper, steel. Wet gas - glass, hard rubber, silver, earthenware	91.7 (liquid at 32°F)	0.063 at 50°F 0.047 at 86°F	99.8% Cl_2	Toxic gas. Solutions in water highly acidic and corrosive.

Table 5-1. Principal Chemicals Used in Water Treatment (Continued)

Chemical Name and Formula	Common or Trade Name	Purpose	Shipping Containers	Suitable Handling Materials	Bulk Density lb/cu ft	Solubility lb/gal	Commercial Strength	Characteristics
Calcium hypochlorite Approx. $\text{Ca}(\text{OCl})_2 \cdot 4\text{H}_2\text{O}$	"HTH", "Perchloron", "Pittchlor"	Disinfection	5 lb. cans, 100-300-800 lb. drums	Glass, rubber, stoneware, wood	48	Approx. one	70% "available" chlorine	
Potassium permanganate KMnO_4	Purple salt	Taste-odor control	Bulk, barrels, drums	Iron, steel, plastics	90-100	0.5 at 70°F	98%	Danger of explosion on contact with organic matter
Activated carbon (powdered)	Powdered activated carbon	Taste-odor control	Bags, bulk	Dry-Iron, steel, Wet-rubber, silicon stainless steel	8-28	Insoluble (used as a 1 lb/gal slurry)	-	-
Activated carbon (granular)	Granular activated carbon	Taste-odor control	Bags, bulk	Dry-Iron steel, Wet-rubber, silicon, stainless steel	22-36	Insoluble	-	-
Calcium oxide CaO	Quicklime, burnt lime, chemical lime, unslaked lime	pH control	80 lb. bags; 100 lb. barrels, bulk trucks (carloads or trucks)	Asphalt, cement, iron, rubber, steel	55-60	Slakes to form hydrated lime	75-99% CaO	pH of saturated solution is 12.4
Carbon dioxide CO_2	Carbon dioxide	ph control	20-50 lb. cylinders, 10-20 or 18-20 ton tank trucks, 30-43 ton tank cars	Dry-iron, steel, Wet-rubber, ceramics	63.7 at 0°F (liquid)	0.03 at 32°F 0.014 at 68°F 0.008 at 104°F	99.9% CO_2	pH of saturated solution at 68°F is approx. 4.0.
Sodium chloride NaCl	Common salt, salt	Sodium zeolite regeneration	Bags, barrels, bulk trucks (carloads)	Bronze, cement, rubber	Rock 50-60 Fine 58-70	2.9 at 32°F 3.0 at 68°F 3.0 at 86°F	96% NaCl	Corrosive when moist.
Sodium hexametaphosphate	Polyphosphate, glassy phosphate, vitreous phosphate	Corrosion inhibitor	100 lb. bags, 100-320 drums	Hard rubber, plastics, stainless steel	Crystal 78 Flake 81 Powder 64	Highly soluble	67% P_2O_5	pH of 1% solution is 6.7-7.2

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